management approach. The underlying rationale of wetlands restoration is that rehabilitating the appropriate physical-chemical habitat in priority locations will contribute to the recovery of sustainable populations of the species of concern. The loss of these wetland habitat types is assumed to be causally linked to declines in these key species. These causal links have not been well established and habitat manipulations, designed as careful experiments on differing spatial and temporal scales, hold promise for determining the relationships that can help guide restoration efforts. However, a major concern remains that the restored habitat will be successfully colonized by non-native rather than native species.

Additional information is needed about life history and species needs relative to inundation (water depth) and salinity regimes in tidal wetlands, required by key native or non-native wetland species. The growth and reproduction of selected species of concern and their linkage to inundation-salinity (in tidal marshes) regimes in given wetland plant communities needs to be better understood to facilitate successful wetland restoration projects. Identification of limiting factors which determine the distribution and abundance of selected wetland species of concern for various inundation-salinity regimes will also facilitate increased success of restoration efforts. Evaluation of spatial characteristics (size, shape, and connectivity) for their effect on the population dynamics of selected freshwater or tidal wetland species, especially their colonization or extinction rates, should be conducted or included as part of physical interventions. This uncertainty might be addressed by making multi-year observations of arrays of habitats that differ in size, shape, and/or connectivity (nearest neighbor characteristics) or by creating such an array of habitats by planting and/or removing selected habitat patches.

Because of the complexity of wetland habitats it will be important to identify and justify animal species that can be used as indicators of acceptable wetland conditions. For example, the sustainable presence of species with long life cycles that are sessile and/or have poor dispersal habit could be good indicators of acceptable stable conditions.

7. CONTAMINANTS IN THE CENTRAL VALLEY

The Bay-Delta ecosystem receives a large variety of potential toxicants (Gunther et al., 1987; Davis et al., 1992). These include significant quantities of selenium from agricultural practices, mercury from historical gold mining and refining activities, pesticides from a variety of agricultural and home uses, polynuclear aromatic hydrocarbons from automobiles, and other metals from a variety of geochemical cycles accelerated by human activities. Moreover, there is a legacy of persistent chlorinated hydrocarbons whose effects appear to be as potentially as serious as those from any current practices. High exposures of aquatic organisms to many of these compounds occurs in the late winter and spring, when water runoff from land is greatest and many aquatic species reproduce (Adams et al., 1996) and whose eggs, larvae and juveniles are the most susceptible stages to contaminants.

Many uncertainties remain about contamination in the Delta. It is known that contaminants enter the Delta: selenium from the Western San Joaquin Valley, pesticides from both the Sacramento and San Joaquin watersheds, mercury from mines and other sources, copper used as an algaecide, PAHs, MTBE and perhaps TBT from heavy boat traffic, and metals from mining. Temperature effects on habitat suitability is also in need of study. Yet not one of these has been studied systematically or in detail in any Delta environment. Although the last several years have seen great advances in our understanding of the distribution and abundance of contaminants in the estuary (e.g., SFEI, 1995), there has not been as much emphasis on defining contaminant exposures in the Sacramento and San Joaquin Rivers and the Delta. Moreover, we have no comprehensive understanding of the risk that contaminants might pose to the health of individuals and populations in the estuary or upstream of the tidal portion of the ecosystem. To improve our understanding, we must determine the degree of contaminant exposure to aquatic organisms, if there is link between exposure and sublethal and chronic toxicity, and then use the exposure-effect relationships to determine the risks to aquatic populations in the catchment of the Bay-Delta.

It is also unclear how restored habitats, such as wetlands, will affect the transport, conversion, and bioavailability of contaminants (e.g., mercury). Examining the relationships between contaminant exposure and effects on organisms is critical to our understanding the links between the two. Actions in one area may have profound effects in another. There is also need to go beyond traditional toxicity tests and examine the overall survival and reproductive potential of organisms. Each contaminant is associated with specific target organisms and possibly target impacts on the organism. Synergistic effects upon biota of the multiple contaminants entering the system need to be evaluated. Such studies will provide insight on effectively restoring an organisms' health.

8. Beyond the Riparian Corridor

Efforts made to acquire or manage lands beyond the riparian zone can have multiple benefits. Not only can they be used to expand functional floodplain to allow natural flooding and stream meander, but they can also be managed or enhanced to provide habitat for a number of native species at risk or in decline. Habitat types found beyond the riparian corridor that support species of concern include a variety of wetland types, including: seasonal wetlands (such as vernal pools and flooded fields), perennial grasslands, and inland dune communities. A number of native species in these "upland" areas—such as waterfowl and game birds, Swainson's hawk, greater sandhill crane, California tiger salamander and western pond turtle--appear to thrive in certain agricultural lands managed to benefit wildlife species. Other species exhibit greater habitat specificity and many have suffered population declines or extirpations from past disturbances and conversion of valley bottom areas adjacent to stream channels and riparian zones. Included are such species as salt marsh harvest mouse, valley elderberry longhorn beetle, giant garter snake, and Lange's metalmark butterfly.

It is often difficult to determine the extent to which the status and trends of particular species populations are controlled by natural variability, and to what extent they are the product of human disturbances. Consequently, it is difficult to know if observed changes in the ecosystem are attributable to restoration and management actions or if they are driven by conditions beyond human control. Developing a better understanding of species-habitat interactions, species-species interactions, and species responses to variable ecosystem conditions is essential to make efforts to recover sensitive species more effective.

It is also important that progress is made toward improving and quantifying the understanding of how areas adjacent to riparian zones, in particular agricultural lands, influence ecological health. It is currently unknown how most species respond individually to disturbances common in landscape areas adjacent to riverine systems, including crop and dryland agriculture, land development, and invasion of non-native species. In California, ecosystem restoration actions are most often the neighbor to agricultural areas. Important questions remain about how agricultural practices can be enhanced or modified to improve ecological conditions and species health. Alternative pest management and fertilizer practices, cropping patterns, the use of no-till agriculture or winter flooding, and the establishment of buffer zones around cropped areas are all areas where pilot scale projects could yield information about how to best implement these types of practices on a large scale and the quantify the benefits associated with them.

There are also agricultural lands and other open space which are considered to be important in their current condition adjoining habitat areas or which have potential for future ecosystem restoration that are at risk of urban development. These areas would benefit from conservation or agricultural easements to preserve the current land use. Another significant concern remains over the potential third party impacts to areas adjoining restoration lands. Rural and agricultural communities have the greatest potential to be influenced by large-scale restoration actions, and there are concerns regarding the potential for adverse economic and regulatory effects from converting agricultural lands to ecosystem restoration areas.

9. X2 Relationships

Current management of the Bay-Delta system is based in part on a salinity standard known as the "X2" standard. This standard is based on empirical relationships between various species of fish and invertebrates and X2 (or freshwater flow in the estuary). Positive relationships with flow (negative with X2) have been observed for several estuarine-dependent species as well as some anadromous species during their migration through the Delta. As with all empirical relationships, these are not very useful to predict how the system will respond after it has been altered by various actions in the Delta, including altered conveyance facilities. This uncertainty illustrates a broader issue: a lack of predictive capability for determining how the ecosystem might respond to changes in its flow regime. This predictive capability will need to be developed to the point where it can support critical decisions about future restoration actions. This implies a need to determine the underlying mechanisms of the X2 relationships so that the effectiveness of various actions in the Delta can be put in context with this ecosystem-level restorative measure.

10. Decline in Productivity

Productivity at the base of the foodweb has declined throughout the Delta and northern San Francisco Bay. Although some of this decline can be attributed to the introduced clam *Potamocorbula amurensis*, or Asiatic clam, not all of the decline is explained. The decline at the base of the foodweb has been accompanied by declines in several species and trophic groups, including mysids and longfin smelt. The long-term implications of this suggest a potential reduction in the capacity of the system to support higher trophic levels, which could limit the extent to which Bay-Delta fish populations can be restored unless creative solutions can be found to increase foodweb productivity.

It is also unclear how actions in the watershed influence estuarine foodweb productivity. For example, more frequent inundation of floodplains and bypasses may stimulate estuarine, as well as riverine, productivity by supplying larger loads of carbon and nutrients to the estuary.

Because we know little about the different sources of decline in productivity at the base of the foodweb, and how non-native species have changed, and are changing, foodweb dynamics, early efforts to address this uncertainty will likely emphasize monitoring, research, and modeling projects that address the issue of decline in foodweb productivity. Examples of projects include:

- Research to examine how introduced species have changed foodweb dynamics, and how efforts to control or eradicate introduced species may affect foodwebs;
- Monitoring and research to identify and examine other potential sources affecting productivity at the base of the foodweb, such as contaminants;
- Monitoring, research, and modeling to examine the role of carbon and nutrients introduced from bypasses and rivers in stimulating estuarine productivity;
- Monitoring and research to understand how the restoration of geomorphic processes (such as bed mobility) and riparian vegetation stimulates aquatic invertebrate production, and how this in turn affect fish survival and growth.

Several types of implementation projects can also be structured and monitored to address uncertainties about foodweb productivity. For example, gravel augmentation projects can include monitoring of aquatic invertebrates. Riparian re-vegetation projects can include complementary monitoring to assess the relative role of insect drop and aquatic invertebrates in fish growth. Projects that create shallow-water habitat can monitor the exchange of carbon between open water environments and the restored wetlands.

11. Diversion Effects of Pumps

Both the State Water Project (SWP) and the Central Valley Project (CVP) have large-capacity pumping facilities located in the southern Delta, where they divert water into the California Aqueduct and the Delta-Mendota Canal for delivery to the San Joaquin Valley and Southern California. Pump operations can affect the circulation of water, and therefore biota, in interior Delta channels and sloughs. The pumps are a source of mortality for several species, including protected fish species. However, it is unclear to what extent pump operations affect the population size of any one species of fish or other biota, or by what mechanisms the pumps most affect fish and biota. For example, the pumps can be a source of direct morality through diversion, impingement upon fish screens, or handling mortality associated with fish salvage operations. The pumps can also have indirect affects upon fish and other biota. For example, the pumps can expose fish to higher rates of predation by drawing them into Clifton Court Forebay, which provides habitat for non-native warm-water fish species that prey upon native fish species. Similarly, the pumps can affect the survival of fish and other biota by drawing them toward the southern Delta, where there is generally less habitat available to support them. By altering the normal circulation patterns of water in the Delta, the pumps can also affect fish survival by altering migrational cues. Because the mechanisms underlying entrainment are not clear, it is unclear which restoration strategy, or mix of strategies, will most reduce the effects of pump operations on sensitive fish species.

It is also unclear to what extent other sources of Delta mortality affect the population of any given species, which has a bearing upon the relative importance of entrainment in the SWP and CVP pumps as a source of mortality. For example, there are thousands of agricultural diversions located in the Delta, and it is unclear how important they are, both individually and cumulatively, as a source of mortality for any given species of fish. Similarly, it is unclear to what extent water quality in the Delta affects the survival of biota or the population dynamics of any given species.

More information on the ecological and biological effects of entrainment and altered hydrodynamics will be pivotal for CALFED in choosing a water conveyance method, because it will help determine to what extent an isolated conveyance facility can be expected to alleviate conflicts between sensitive fish species and Delta exports. Reducing this uncertainty is also essential to ensure that the expenditure of restoration funds is well targeted.

Implementation projects conducted as adaptive management experiments will be necessary to better understand the relative importance of entrainment in the SWP and CVP pumps as a source of mortality for individual species, as well as the underlying mechanisms. Such implementation projects will require advance planning to manage risks to important resources, such as protected fish species and water supplies, and since the expense of such implementation projects will likely be significant. Such advance planning will include the development of conceptual models, simulation modeling, and decision modeling to guide the selection and design of adaptive management experiments, expanded monitoring, and targeted research. The use of an Environmental Water Account (EWA) will provide an early opportunity for adaptive management experiments designed to study the mechanisms underlying the diversion effects upon Delta ecology and biology.

12. THE IMPORTANCE OF THE DELTA FOR SALMON

Scientific opinion varies on the suitability and use of the Delta for rearing by juvenile salmon and steelhead. Although chinook salmon use other estuaries for rearing, most research on salmon in the Delta, and resulting protective measures, focus on smolt passage. However, if substantial numbers of salmon fry rear in the Delta and these fish contribute substantial recruitment to the adult population, then current actions to protect migrating smolts (e.g., pulse flows) might be modified or supplemented by actions designed to protect resident fry (e.g., extended high flows to flood shallow areas).

Early efforts to address this uncertainty will likely emphasize monitoring, targeted research, modeling, and pilot projects. Examples of such projects include:

- Expanded monitoring and research to better determine what fraction of salmon fry rear in the delta for different salmonid species, and which tributaries contribute larger fractions of salmon fry;

- Research to evaluate the survival of salmon fry that rear in the Delta versus the survival of fry that rear in tributaries;

- Research and monitoring to determine if Delta fry rearing is a life history strategy, a function of lack of rearing habitat in tributaries, and/or a function of tributary flow patterns;

- Population modeling to evaluate actions that emphasize Delta rearing and actions that emphasize smolt passage through the Delta; and

- Pilot projects that provide Delta rearing habitats for salmon fry and monitor their use.

SEIZING UPON RESTORATION OPPORTUNITIES

There are many opportunities to build upon existing restoration efforts in the Bay-Delta ecosystem, including ongoing and recent restoration projects funded by Category III, CVPIA, and CALFED's Restoration Coordination programs. Several local and regional watershed groups have also completed or are conducting restoration planning efforts that will facilitate the selection and implementation of restoration actions. For example, the Upper Sacramento River Fisheries and Riparian Habitat Plan (SB 1086) can help guide restoration of the Upper Sacramento River. There are also opportunities to implement large-scale restoration projects in the Bay-Delta ecosystem that will enable resource managers to test different hypotheses and to refine restoration methods, thereby contributing not only to the long-term Ecosystem Restoration Program, but also to restoration science in general.

This section identifies some promising opportunities for initiating large-scale ecological restoration in Stage 1 of the ERP. These are only a sample of the opportunities for ecological restoration that would potentially benefit endangered species, as well as other native species. The restoration activities described below have not been subjected to the adaptive management process described earlier in this chapter. A more rigorous assessment of the costs and benefits of the following activities might indicate that some of these projects are less promising than imagined. This list of opportunities is illustrative; it is meant to demonstrate the types of restoration activities available in the ERP.

The choice of specific examples was guided by the principles that were established in the strategic plan: that restoration of endangered species is best approached through restoration of the ecological structures and processes on which the species depend and that habitat restoration and maintenance is a dynamic, not a static, process. In light of these principles, opportunities have been identified that focus on ecological processes and that could be implemented in ways that would be largely self-sustaining. For example, opportunities identified for Bay-Delta tributaries emphasize the restoration of physical and ecological processes, rather than artificial measures to maintain populations, such as hatcheries or creation of habitats that will not be sustained by ongoing processes. Examples have also been selected that would generate results within the short timeframe of Stage 1.

OPPORTUNITIES IN THE BAY-DELTA

1. **REDUCE THE INTRODUCTION OF BALLAST-WATER ORGANISMS FROM SHIPS TO 5% OF 1998 LEVELS.** The shipping industry can greatly reduce and eventually eliminate the introduction of organisms through ballast water using existing technology. Significant progress could also be made in reducing the introduction of non-native species from other sources as well. This is a preventative rather than a restorative activity. Given the impacts that introduced invasive species have already had on the ecology of the Bay-Delta ecosystem, however, the eventual elimination of all additional species introductions is crucial to the ultimate success of the ERP.

2. **EXPAND OR ENHANCE SEASONAL SHALLOW-WATER HABITAT IN THE BYPASSES (E.G., YOLO BYPASS) AND NEAR-**

Delta floodplains. The bypasses and other "artificial" floodplains that flood during wet years are demonstrably productive places for juvenile salmon and splittail, as well as waterfowl. By re-engineering the weirs that release water into the bypasses, the bypasses presumably can be flooded (at least partially) on a more regular basis and could therefore be productive in most years. Habitat creation in flood bypasses presents one of the best opportunities for ecosystem restoration because large areas of habitat can probably be created at small cost while retaining the flood management functions of the bypasses.

3. **Initiate several large-scale pilot projects using different approaches to restoring tidal marshes in the North Delta (around Prospect Island), Suisun Marsh, and the North Bay.** These projects could be designed as experiments to assess the benefits for marsh-dependent species and the most effective techniques of restoration, as well as providing an opportunity to evaluate options for minimizing or controlling invasive plant species. Note also that this kind of project represents an implementation of the three levels of adaptive management action: targeted research, pilot testing of techniques, and large-scale restoration.

4. **Develop means to control invasive aquatic plants in the Delta.** Invasive plants, such as water hyacinth and *Egeria densa* (Brazilian water weed), are clogging many sloughs and waterways of the Delta, not only impeding boat traffic, but also creating environments that are unfavorable for native fishes. The California Department of Boating and Waterways has an Egeria control program, but has not yet received CEQA approval for use of chemical controls. There is an immediate need to develop ways by which to control these plants that are not, in themselves, environmentally harmful. An opportunity exists for the ERP to join forces implementing ambitious eradication and control measures with agencies, organizations, and water districts concerned with the deleterious effects of these water weeds on navigation in the Delta, clogging of water intakes and fish screens, and diminished recreational uses.

5. **Initiate targeted research on major restoration issues, such as: (1) how to control problem invasive species such as the Asian clam (*Potamocorbula amurensis*) which has a negative effect on foodweb dynamics in the estuary; (2) factors limiting the abundance of high-priority endangered species; and (3) design of habitats for shallow-water tidal marsh and bypasses.** Use such research to begin addressing issues raised in the twelve issues above. Ultimately, the limited funds available for restoration will be much more effectively spent if there is a clear understanding of the relative seriousness of the diverse problems facing the estuarine and riverine ecosystems and of the ability to solve those problems. Where the research can be linked to pilot or large-scale restoration projects, the benefits will be multiplied.

6. **Coordinate with the various levee and flood control state, local, and federal programs to establish design criteria and standards that ensure that levee rehabilitation projects incorporate features beneficial to the aquatic and riparian environments of the Delta.** The majority of the approximately 50 Delta islands are hydrologically disconnected by levees from the primary channel, open-water estuarine environment. Most of these levees are likely to remain in future years and to be reinforced with rock riprap, raised and widened, or rehabilitated in other ways to prevent levee failure. Potentially beneficial projects that could be incorporated into these programs include levee setbacks and creation of broad submerged benches, as well as the construction of broader levees to support riparian vegetation. Developing contingency plans for responses to major and multiple levee failures in different parts of the Delta can also provide ecosystem benefits and minimize disturbances associated with levee repair.

7. **ESTABLISH LARGE-SCALE PILOT PROJECTS ON BOTH LEVEED DELTA ISLANDS AND ON SUBMERGED ISLANDS (E.G. FRANK'S TRACT) TO TEST AND MONITOR TECHNIQUES FOR RETURNING SUBSIDED DELTA ISLANDS TO SHALLOW-WATER AND MARSH HABITATS.** On leveed islands, areas could be diked off, partially flooded, and planted with tules to examine the potential for natural deposition of organic matter to raise island levels. On submerged islands, dredge spoils and other materials could be used to create shallow-water habitats. One potential benefit of a project to convert parts of Frank's Tract to shallow-water habitat would be reduction of wave erosion affecting Delta island levees surrounding the tract.

8. **DEVELOP LARGE-SCALE PILOT PROJECTS THAT EXAMINE THE RELATIONSHIP BETWEEN VARIABLE SALINITY AND THE MAINTENANCE OF NATIVE SPECIES IN THE DELTA, ESPECIALLY IN SHALLOW-WATER HABITATS.** Historically, the Delta and other parts of the estuary had salinity regimes that fluctuated from year to year as well as from month to month and, often, daily with tides. The native organisms presumably evolved in such variable conditions and should be favored by them. Many of the non-native species (e.g., freshwater aquatic plants, freshwater and marine clams), in contrast, may be favored by the more stable conditions now present as the result of regulation of freshwater inflows into the Delta. Opportunities exist to restore large tracts of former tidal shallow-water habitat in the north Delta, lower Yolo Basin, and along river channels and sloughs in the vicinity of Sherman Island. Once these shallow-water habitats are in place, it may be possible to vary the position of the salinity gradient in these areas, thereby testing the effects of variable salinity on native and introduced organisms in the shallow-water habitats. This action would provide valuable information on such things as: (1) the extent to which physical habitat may be limiting native and introduced species, (2) how salinity gradients and variability affect conditions and species within the shallow-water habitats, and (3) calibration of models to evaluate the changes in the hydraulics of the Delta that would result from having more extensive tidelands and more breached Delta islands.

OPPORTUNITIES FOR RIVERS

1. **MIMIC NATURAL FLOW REGIMES THROUGH INNOVATIVE METHODS TO MANAGE RESERVOIR RELEASES.** There is underutilized potential to modify reservoir operations rules to create more dynamic, natural high-flow regimes in regulated rivers without seriously impinging on the water storage purposes for which the reservoir was constructed. Water release operating rules could be changed to ensure greater variability of flow, provide adequate spring flows for riparian vegetation establishment, simulate effects of natural floods in scouring riverbeds and creating point bars, and increase the frequency and duration of overflow onto adjacent floodplains. In some cases, downstream infrastructure of river floodways may require upgrading to safely accommodate a more desirable natural variability and peak discharge magnitude associated with moderate floodflows (e.g., strengthen or set levees back).

2. **MIMIC NATURAL FLOWS OF SEDIMENT AND LARGE WOODY DEBRIS.** Dams disrupt the continuity of sediment and organic-debris transport through rivers, with consequent loss of habitat, and commonly, river incision, downstream. In some cases, such as Englebright Dam on the Yuba River, dam removal can be considered as a potential solution to reestablishing continuity of sediment and debris transport, as well as opening access to important spawning and rearing areas. Most dams, however, cannot be removed, so methods must be sought to reestablish continuity of sediment and wood transport with the dam in place. Coarse sediment can be artificially added below dams to at least partially mitigate for sediment trapping by the dam and ameliorate the impacts of sediment-starved flows. This approach has been successfully used in Europe, using sediment from natural (landslide) and artificial sources (injected from barges). On

the River Rhine, enough gravel and sand are added below the lowest dam to satisfy the present sediment transport capacity of the Rhine to prevent further incision of the bed (an average of over 200,000 cubic yards annually). On the Sacramento River, gravels have been added at a rate much below the river's transport capacity so they are vulnerable to washout at high flows. A more sustainable approach would be to add gravel (and sand) on a regular basis and at a much larger scale to better mimic natural sediment loads and therefore provide the sediment from which the river would naturally create and maintain spawning riffles. This latter approach requires a large commitment of resources and should be undertaken only in rivers where other factors (e.g., temperature regime) are favorable (or can be made favorable) for recovery of species (such as the upper Sacramento). Such opportunities will be more economical where sources of dredger tailings or reservoir Delta deposits are available nearby.

While recognizing the navigation and flood safety issues associated with large woody debris in rivers, the importance of this debris to the foodweb and structural habitat for fish should not be overlooked. There is an opportunity to investigate ways by which to pass debris safely through dams and bridges. This may require replacing some existing bridges with those less prone to trapping woody debris.

3. **IDENTIFY AND CONSERVE REMAINING UNREGULATED RIVERS AND STREAMS AND TAKE ACTIONS TO RESTORE NATURAL PROCESSES OF SEDIMENT AND LARGE WOODY DEBRIS FLUX, OVERBANK FLOODING, AND UNIMPAIRED CHANNEL MIGRATION.** Most rivers in the Central Valley are regulated by large reservoirs and therefore require considerable investment to recreate the natural processes needed to sustain true ecosystem restoration; however, a few large unregulated rivers still exist, such as the Cosumnes River and Cottonwood Creek. Lowland alluvial rivers and streams with relatively intact natural hydrology should be identified and made a high priority for acquisition of conservation and flooding easements, setting back of levees, and other restoration actions because such actions on these rivers are likely to yield high returns in restoration of natural processes and habitats and, ultimately, fish populations.

4. **UNDERTAKE FLUVIOGEOMORPHIC-ECOLOGICAL STUDIES OF EACH RIVER BEFORE MAKING LARGE INVESTMENTS IN RESTORATION PROJECTS.** River ecosystem health depends not only on the flow of water, but on the flow of sediment, nutrients, and coarse woody debris and on interactions between channels and riparian vegetation, variability in flow regime, and dynamic channel changes. It is only through interdisciplinary, watershed, and historical scale studies that the constraints and opportunities particular to each river can be understood. For example, it was only after a fluviogeomorphic study of Deer Creek that the impact of flood control actions on aquatic and riparian habitat was recognized, a recognition that has lead to a proposal for an alternative flood management approach designed to permit natural river processes to restore habitats along Lower Deer Creek.

5. **UNDERTAKE FLOODPLAIN RESTORATION ON A BROAD SCALE, WHERE LAND OR EASEMENTS CAN BE ACQUIRED AND WHERE THE RIVER HYDROLOGY INCLUDES (OR CAN BE MADE TO INCLUDE) SUFFICIENTLY HIGH FLOWS TO INUNDATE FLOODPLAIN SURFACES.** Restoration of floodplain function can produce many benefits, such as reducing stress on remaining levees, reducing excessive channel scour, and encouraging establishment of riparian vegetation over a larger area within the adjacent floodplain. A range of possible measures will need to be employed to fit local conditions, such as widening flood bypasses or creating new ones; setting levees back, creating backup levee systems, or deauthorizing specific levee reaches; constructing armored notch weirs in levees and purchasing flood easements to restore floodbasin storage functions; or implementing measures described in item two above to increase the frequency and duration of overbank flow onto existing floodplains. Reactivating the historical floodplain can

provide effective, reliable and cost effective flood storage while restoring important ecological processes.

6. **Reduce or eradicate invasive non-native shrubs and trees from riparian corridors.** Of particular importance is the control of the spread of tamarisk and giant reed, two introduced species that displace native flora, offer marginal value to fish and wildlife, and cause channel instability and reduced floodway capacity. Some rivers, such as Stony Creek and Cache Creek and the lower San Joaquin River, have undergone large expansions of these non-native species, even in the past 10-15 years. A combination of large-scale eradication pilot projects and targeted research on several streams will help to temporarily reduce the rate of expansion of their range, identify the most vulnerable stream environments, and determine whether valley-wide eradication or suppression measures are warranted or feasible.

7. **Remove barriers to anadromous fish migration where feasible.** Significant progress has been made in recent years to improve salmon passage on several spawning streams (e.g., Butte Creek, Battle Creek) by removing barriers, consolidating diversion weirs, or constructing state-of-the-art fish passage structures. Existing and potential spawning areas in the ERP focus area that are not obstructed by major reservoir dams, but are currently obstructed by other barriers, should be identified and action taken to restore anadromous fish spawning upstream.

8. **Develop a partnership with the Army Corps of Engineers, Reclamation Board and DWR to fully integrate river and floodplain ecological restoration with flood management measures being considered in the 4-year Comprehensive Study underway for the Sacramento and San Joaquin River basins.** Many of the ecological approaches to river restoration listed above are feasible only if and when the overall capacity of the Valley flood control system is expanded and the risk of flooding farms and cities has been significantly reduced. In other words, more room within the managed floodways must be made available for the "roughness" of habitats and the ecologically desirable tendency of alluvial river channels to migrate by eroding of banks or spread high flows onto natural floodplains. Pilot projects and studies should be initiated that test innovative solutions to improve floodplain management with significant ecosystem benefits, such as the proposed floodplain restoration projects under evaluation along the lower San Joaquin and Cosumnes Rivers.

9. **Promote and support river-based conservancies and broad coalitions to resolve conflicts and achieve local consensus over the restoration and management of river corridors.** Local coalitions with technical and financial support from CALFED, CVPIA, and other state and federal programs have been successful at reaching broad agreement on solutions and implementing projects to restore river habitats and recover threatened fish populations. Expanding financial and technical assistance throughout the ERP focus area can yield similar benefits in other ecological management units.

Regulatory Compliance

The proposed Stage 1 actions will also need to be reviewed to determine which can be covered adequately by the Programmatic EIS/EIR and which will require additional, site-specific (second tier) environmental documentation and the acquisition of regulatory permits. Most proposed ERP actions will require additional documentation, so it will be important to ensure that the proposed Stage 1 actions will be ripe for implementation by identifying the permitting and environmental documentation requirements for each action and estimating the time required to complete them. Since the acquisition of regulatory permits and preparation of environmental documents can delay the implementation of the program, it is important to streamline the regulatory compliance process. Two mechanisms to facilitate compliance include bundling actions and building off of permits and documentation from other actions. It is possible to bundle multiple ERP and related non-ERP CALFED actions so that they are covered by a single document or permit, thereby saving time and the cumulative impacts of the actions are more adequately described. It may also be possible to build off of permits or reference environmental documents prepared for restoration actions already underway through CVPIA, Category III, and CALFED Restoration Coordination programs. (See the CALFED Handbook of Regulatory Compliance [1996] or the Regulatory Compliance Technical Appendix in the Revised Draft EIS/EIR for a more detailed description.)